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ITS CAUSES AND SOURCES, AS EXPLAINED BY THE
GERM THEORY OF DISEASE.

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TYPHOID FEVER: ITS CAUSES AND SOURCES, AS EXPLAINED BY THE GERM THEORY OF DISEASE.

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IN the following paper I have endeavored, by digesting the work of others, to give to the profession a clear and concise argument for the germ theory as applied to typhoid fever. And I have done so because, as it seems to me, this offers the only logical explanation of *the sources, causes, and symptoms* of that most important and insidious disease. In the preparation of this paper I have consulted a large number of works and periodicals. But I hold myself especially indebted to the very valuable work on *The Germ Theory of Disease*, by T. MacLagan, M. D., which should be carefully studied by all interested in the subject.

CAUSES.

Among the many questions now agitating the mind of the scientific world there is perhaps no one of more vital importance than the *cause* of that class of diseases generally known as the zymotic diseases, but more properly as the specific or continued fevers, as, for example, cholera, small-pox, yellow fever, typhus fever, scarlet fever, typhoid fever, cerebro-spinal fever, diphtheria, measles, etc.

Although these diseases have each its own peculiarities, they yet have many traits in common, pointing to a similarity of causation; each has a more or less definite period of incubation; each is marked especially by the phenomena of fever, by a characteristic local lesion, by a more or less definite period of duration, by being more or less contagious, by occurring, as a rule, but once in a life-time. Where there are so many points in common it is natural and rational to infer that there is a *similarity* of causation. But we cannot go farther and say that they arise from the same cause, because we know that they never breed each other. A case of small-pox imported into a neighborhood never gives rise to measles, nor does a case of typhus ever give rise to diphtheria. In other words, they *always* breed true. In looking, then, for the cause of either one of these diseases, we must be content with no theory which is not applicable to all of the group, that is, in explaining the points of similarity above noted. And, without taking time or space to give the history of all the causes that have been proposed, natural and supernatural, organic and chemical, we will come at once to the point, and express our conviction that in the germ theory of dis-

ease, as lately developed, we have found the true solution of the difficulty.

The germ theory is not new, having been several times suggested in past ages; but of late years it has received much attention from some of the brightest minds in the profession, as well as from others already distinguished in different branches of science. But by the latter it has been mostly studied from the biological point of view, and has been considered by them largely with reference to the theories of evolution and spontaneous generation. The latter theory especially is intimately connected with our subject, but the intention and scope of this paper preclude its extended consideration. Suffice it to say, then, that the weight of evidence to date is entirely opposed to the theory of spontaneous generation.

What is the germ theory of disease? It is the belief that certain diseases are produced by the reception into a susceptible system of *specific* organisms, germs, or contagia possessing almost unlimited powers of reproduction.

The first question is, What is a contagium? In his masterly work on the subject, MacLagan says: "A contagium is a morbid agent which is propagated in and given off from the bodies of the sick, and is capable, when received into a susceptible healthy body, of producing in that body a disease similar to the one during whose course it was formed."

By a series of ingenious investigations, M. Chauveau and Dr. Burdon-Sanderson have proved that the contagium is composed of minute *particles*, which are neither soluble nor diffusible; and from the fact that they have eluded every chemical test it is fair to infer that they are organic, and differ very little from the fluids in which they are known to be contained. The contagium was supposed to be a variety of bacteria, but Dr. Bastian has shown that as fluids known to be contagious develop bacteria, in just so much do they lose their contagious properties. Moreover, bacteria are now recognized as a result of the decomposition of organic matter, and in the case of contagious fluids it is thought that they may be developed from decomposition of the contagia themselves. Probably no one has ever yet seen a contagium, although Dr. Beale and other microscopists have with very high powers made out a mass of "fine granulations" which they have supposed to be contagia. But no glass has yet been made powerful enough to individualize and differentiate them. From the action of the contagia within the body we know that under favorable circumstances they have an almost infinite power of reproduction. "The characteristic quality of a contagium, or virus of a communicable disease, is its capacity of undergoing almost unlimited multiplication when introduced into an appropriate medium."¹

¹ Dr. Baxter, Reports of the Medical Officer of the Privy Council, New Series, No. VI. 1875.

“The poisons of infectious diseases can reproduce themselves, and to an unlimited extent. With a minimum quantity of vaccine virus we can vaccinate a child and obtain vaccine matter from him. From this child ten or even more children can be successfully vaccinated; so that what at first was a scarcely appreciable quantity of the virus of the disease is sufficient to produce the disease in one, ten, one hundred, one thousand, ten thousand, children, and so on *ad infinitum*.”¹

“Of all perishable things protoplasm is the most perishable.” And this dictum holds perfectly true in regard to the protoplasm of contagia, for on exposure to the air they are quickly destroyed. At the same time, under favorable protecting influences, they may retain their power of contagion for a very long period. It will not be necessary to offer proof of this, as every physician will remember examples in his own practice.

This, then, sums up what we know of the contagia: (1) that they consist of minute particles, which are neither soluble nor diffusible; (2) that they are organic; (3) that under favorable circumstances they have an almost infinite power of reproduction; (4) that they always breed true; (5) that they are readily destroyed on exposure to the air, but may under protecting influences retain their virulence for a long time.

One other property these contagia have in common, and in common with all organisms: they require for their support nitrogen and water. And herein we shall principally find the explanation of their effect upon the economy. But after they arrive within the body they can acquire their nitrogen and water *from* the body only; and if they live within the body, and at the expense of the body, what are they? They are *parasites*. Now it is well known that parasites are propagated only in certain localities where they find their own appropriate *nidus*; that different parasites appropriate different localities; and that these localities may be of very small extent. While these contagia, then, as organisms may be able to live wherever they can find a sufficiency of nitrogen and water, as parasites they can reproduce themselves and multiply only where they find their appropriate *nidus*.

By considering contagia in this light, as parasites, we can explain many points heretofore clouded in mystery. When we understand that each disease has its own contagium, which, being a parasite, requires its own particular *nidus*, we can easily understand why these diseases always breed true; also, wherein susceptibility consists. Why is it that one person escapes the disease to which others are falling victims? Formerly no satisfactory answer was possible. Now we know that, for some reason or other, the *nidus* is absent. From some individual peculiarity it may never have been present; from some particular cause — as pregnancy — it may be temporarily lacking; or from a previous at-

¹ Liebermeister, Ziemssen's Cyclopædia of the Practice of Medicine, vol. i., page 9.

tack of the same disease it may have been exhausted. And thus we can also account for the fact that these diseases occur, as a rule, but once in a life-time; the nidus is exhausted and not reproduced. Further on we shall see that the necessary nidus for the contagium of each disease is undoubtedly located at that point where the characteristic local lesion of that disease afterwards occurs.

Typhoid fever is one of the least contagious of the specific fevers. And why? Because its nidus is found in the ileum, and the chances of the contagia reaching this point are comparatively small. The contagia may be taken into the circulation through the lungs, but it is quite conceivable that they might be so received, even in considerable numbers, and yet never succeed in reaching the only place where they could fructify. But the contagia of typhoid fever are usually, without doubt, conveyed into the system along with food or drink, and then the road to the ileum is a broad and easy one, which too often "leadeth to destruction." Each one of this group of diseases has its own tolerably definite period of incubation. During this time the contagia are actively multiplying and spreading themselves through every tissue of the body. This period of incubation is terminated by a general *malaise*, accompanied by headache; then one or more chills are experienced; and from these we generally date the commencement of the disease. We do not know — and probably never shall know — how many contagia are necessary to produce the disease, nor at what rate they are reproduced. But it is perfectly rational to suppose that the severity of the case will depend, first, on the number of the contagia received, and, second, on the vitality of the nidus in the individual attacked. At first the system takes no note of these invaders. But after a time they multiply and permeate the tissues to such an extent that the system rebels. And why? Because these contagia are appropriating to themselves the nitrogen and water necessary to the support of the body and to the due performance of its functions. It can no longer support itself and them too without increased effort. And, as the contagia still go on multiplying day after day, so must the body put forth greater and still greater effort to accomplish the work forced upon it.

From whence do the contagia derive the supply of nitrogen required for their support? Nitrogen is supplied to the body by means of food, both animal and vegetable, and having passed through the various phases of digestion appears in the plasma, or liquor sanguinis, whence it is taken up and incorporated by the nitrogenous tissues. When it has performed its duty it is given back into the circulation and carried to the liver, where it is changed into urea, and, passing on again, is finally eliminated by the kidneys. Now, as the contagia are organisms, and in a state of strong vital activity, they must (1) require the same food as other nitrogenous tissues, and (2) be more urgent in their

requisition for it. Consequently they step in and appropriate from the liquor sanguinis the supply of nitrogen which, under normal conditions, should go to support the nitrogenous tissues of the body. This explains why in these cases there is such a wasting of those tissues; they are robbed of their food, and are virtually starving. The patient may be taking in nitrogen in ordinary or even in greatly increased quantities, but it is the contagia, and not his own tissues, that are gaining the benefit of it. The *constructive* processes are therefore interfered with to a very serious extent. But at the same time the *destructive* processes are going on, and of course with greater activity, as a necessary result of the increased activity of the circulation. In other words, a greater amount of used-up nitrogenous material is carried to the liver to be changed into urea; and as a natural consequence there is usually an increased amount of urea eliminated by the kidneys. But sometimes we find, on the contrary, that the amount of urea eliminated is decreased instead of increased. And for the explanation of this apparent contradiction we must look still further into the action of the contagia.

Besides nitrogen, the contagia require water in large quantities for their support.

The fever symptoms — heat, dryness, and thirst — are to be accounted for on two grounds. We have seen that in consequence of the presence of the contagia the constructive processes must be very greatly increased, although it is the contagia rather than the tissues of the body that gain the benefit of the increased efforts. But the efforts are made all the same, and through the usual processes. We have seen that the destructive processes are also continued and increased. All this implies hyperæmia and increased circulation, which is not local but general, because the contagia permeate every part and tissue of the body. But fever patients are continually thirsty. Why? Because the contagia are greedily absorbing the water from the body. These patients consume enormous quantities of water, but they eliminate very little. Why? Because the contagia take it up. And now we see why, in some cases, — they are always the worse ones, — there is a deficient elimination of urea. The urea is present in the circulation in greater quantity, but the kidneys cannot obtain a sufficient supply of water to enable them to excrete it. There is therefore a *retention* of urea, which, if it reaches a certain limit, will produce its own toxic effect upon the system. Moreover, after a time the kidneys may become exhausted and congested and inflamed by their over-exertions, and by the excessive amount of urea passing through them, to such an extent as to make them utterly unfit to continue their functions, and then we have *suppression* of urine.

We have seen that the presence of the contagia in the various tissues

of the body necessarily produces an increased circulation, which is general because they are present everywhere. But in each one of these fevers there is a point where the increase of circulation is decidedly more marked, and which results in the characteristic local lesion. In typhoid fever this point is situated in the ileum, and especially in Peyer's patches.

When speaking of the contagia as parasites we pointed out the known fact that parasites are propagated only in certain localities, where they find their own appropriate nidus. Wherein this nidus consists we do not know, but we do know that it constitutes a necessary second factor. In the locality, then, where this nidus exists the contagia are not only present, but undoubtedly in much greater numbers than elsewhere. This fact alone would account for a more marked increase in the circulation. But, over and above this, the contagia are *reproducing* themselves in this locality, and in enormous and constantly increasing numbers. Now, in the higher organisms we know that the phenomena of reproduction are always accompanied by increased heat and circulation, and we may reasonably infer the same with contagia. We have therefore two excellent reasons for *expecting* a decided local hyperæmia at the location of the nidus. And local hyperæmia is essentially the condition of the local lesion in each one of the contagious fevers.

If the local lesion were produced secondarily, by some poison developed by the disease, we can see no reason why in the same disease it should always occur at the same point. But if the disease be produced primarily by a parasite which can find its nidus only in a certain definite locality, we see that there is good and sufficient cause for expecting a marked local hyperæmia at that locality. And this local hyperæmia, in various degrees of intensity, constitutes the local lesion.

We have said that the contagia permeate all the tissues of the body. And when we remember the delicacy and sensitiveness of the nervous system we should naturally expect it to show early and continued evidence of disturbance.

We know that the blood supply of the whole body is regulated by the vaso-motor system of nerves, and that this system is exceedingly sensitive to reflex as well as to direct irritation. In the class of diseases now under consideration this reflex action would arise, in the first place, from the locality of the nidus; for here the contagia are not only present and interfering with the constructive processes of the tissues, but they are reproducing themselves in enormous numbers. All this implies the necessity for an increased supply of blood at this point, and consequent stimulation and irritation of the vaso-motor nerves, which are, of course, by reflex action, communicated to the nervous centres. And as the contagia are multiplied and carried to all parts of the body, so must they also from all parts of the body give rise to irritation of

this system of nerves. But it has been proved that the vaso-motor nerves take their origin exclusively from the cerebro-spinal system. And when we remember that about one fifth of all the blood in the body is carried to the head, we shall see that the brain is likely to be infested with contagia as soon as, or even sooner than, the other tissues of the body, in which case there would speedily be direct as well as reflex irritation of the vaso-motor system.

An urgent demand is made for more blood to assist in the nutritive processes. The vaso-motor system responds by contracting the capillaries and sending the supply of blood with increased rapidity, by the larger vessels, to those points where it is most needed. The consequence is that with increased arterial action we have capillary anæmia.

Now which of the tissues are particularly dependent on the capillary circulation? The brain, spinal cord, and skin. And so in the capillary anæmia of the brain we find the cause of the headache; in a similar condition of the spinal cord we see reason for backache and general weakness; and in a like state of the skin we can trace the origin of chills. And this explanation is particularly satisfactory when we remember that during a rigor the patient has the feeling of cold, while the temperature of the body, as shown by the thermometer, is really increased. As stated above, with increased arterial action we have capillary anæmia.

But as the contagia are still further multiplied, and penetrate to those tissues chiefly or wholly nourished by the capillaries, the vaso-motor nerves *relax their contractile action* so as to allow of the passage of the now necessary supply of blood, and *then* the patient has fully arrived at the condition of *fever*. It is to be remarked that at this time the headache subsides and generally disappears.

The capillary anæmia is, then, but a temporary condition, a stage in the development of the fever, an effort of nature to conserve the equilibrium of her forces. But this effort is soon overpowered by the rapid spread of the contagia, and the duration of this effort is in direct proportion to the number of contagia present,—in other words, to the severity of the case.

But now, as the contagia continue to multiply and to pervade all the tissues in ever-increasing numbers, what condition do we find in the nervous centres? Just the same as in the other nitrogenous tissues: increased circulation and heat, and at the same time starvation and wasting. But organs of such delicacy as the brain and spinal cord cannot stand either the congestion or the starvation without consequent derangement of function. And so, in proportion to the development of these conditions, we find delirium and convulsions and—if relief does not come in time—coma. But we must not forget that another agent may be also working in the same direction. For, as we have already

pointed out, if the kidneys, from previous disease, or from an insufficient supply of water, or from exhaustion, are unable to perform their functions, then an excess of urea remains in the circulation, and superadds its baleful influence to that of the contagia.

But now the question arises, How can this state of things ever end otherwise than in death? If the contagia need only nitrogen and water for their support, why do they not always go on in their rapacious robbery as long as any nitrogen and water remain in the body, and so of course invariably produce death? If we had looked upon the contagia simply as organisms, we could give no plausible answer to these questions. But we have shown good reasons for considering them in the light of *parasites*, and as parasites we have seen that they are absolutely dependent for reproduction on their appropriate *nidus*. But this nidus must sooner or later become exhausted. Now, at the time when this occurs, there must be enormous numbers of the contagia, in various states of development, in the system, and these must of course go on and attain their growth; but in the mean time they are being gradually eliminated by the usual destructive processes of the nitrogenous tissues, and reproduction having ceased their reinforcements are cut off. What, then, occurs within the economy? Why, a reduced demand for nitrogen and water, which produces (1) reduced heat; (2) reduced circulation; (3) an increased water supply for the use of the kidneys; and, (4) partly from the increased water supply, and partly from the relaxed condition of the capillaries, an increased action on the part of the skin. We see, therefore, that the defervescence is caused by, but does not date from, the exhaustion of the nidus; a proportion, at least, of the contagia remaining in the system must be disposed of before relief can be obtained.

In earlier days, the disease was supposed to begin suddenly with a chill, and to cease abruptly with a sweat; but in these days of accurate thermometry, we know that the temperature rises gradually, even before the chill, and abates gradually, even before the sweat. And the reason is plain: the contagia must have increased to a certain degree before they could cause irritation enough to produce the initial chill, and they must have decreased to a certain degree before they could leave a sufficient water supply to enable the excretory organs to resume their functions, and so produce the critical diaphoresis and diuresis.

But, unfortunately, the disease does not always take this favorable turn, and death still occurs in a lamentably large proportion of cases. Now death may be caused either by coma or by asthenia; or, in other words, either by exhaustion of the nervous system, or by exhaustion of the circulatory system. We have seen that coma is produced by the excessive production of the contagia and consequent impairment of the brain, and precisely so asthenia is produced by the excessive produc-

tion of the contagia and impairment of the heart. When we remember the vascularity of the muscles of the heart, and the enormous amount of labor imposed upon them by the febrile conditions of the system, it will not seem strange that they should succumb to combined malnutrition and overwork. But, clinically, we are most apt to find a combination of these two conditions of coma and asthenia, and then we must conclude that the whole system is simply overpowered and swamped by the multitude of contagia.

Of course individual peculiarity must have a very great influence in determining the preponderance of one set of symptoms or the other. In children, and in older patients who are of a decidedly nervous temperament, or who have shown a previous tendency to head symptoms, we should expect more of delirium, convulsions, and coma; and in elderly or weakly patients, and in those who have suffered from any disease of the heart, we should anticipate asthenia. But, aside from such individual peculiarities, we should expect death precisely in proportion to the number of contagia produced; and this may explain a fact which is frequently remarked, viz: that strong, robust patients so often "fare hardly." We may rationally suppose that an exceedingly healthy body would present an exceedingly vital nidus, and so, having received the contagia, reproduce them in unusually great numbers.

Having thus tersely, but we hope sufficiently, explained the causation of typhoid fever and its various symptoms, it is satisfactory to find that we have at the same time given good and sufficient reason for that course of treatment which experience has taught us to adopt as the most satisfactory. By the administration of milk and beef tea we supply the much-needed nitrogen in its most easily digestible forms, and we no longer fear to give water in sufficient quantities.

SOURCES.

Having thus briefly traced the contagium — which is *the cause* of typhoid fever — and its *modus operandi*, let us now inquire into its sources and methods of dissemination.

We have spoken of the contagium as a specific germ. By this we did *not* mean that there is one disease-germ, which, under varying circumstances, may produce different diseases of this group; on the contrary, we mean that each of the contagious diseases has its own specific contagium, which, under favorable conditions, will reproduce that same disease, but which cannot, under any circumstances, cause any other disease. We therefore believe that every case might be traced to a previous case, *if* all the circumstances could be known; and we do *not* believe in the occurrence of cases *de novo*, because the weight of evidence is decidedly opposed to the theory of spontaneous generation.

"The epidemics which spread havoc among us, from time to time,

are not spontaneously generated; but they arise from an ancestral stock, whose habitat is the human body itself. It is not on bad air or foul drains that the attention of the physician will primarily be fixed; but upon disease-germs, which no bad air or foul drains can create, but which may be pushed by foul air into virulent energy of reproduction.”¹

Here we have two points of the greatest importance noted. Our attention must primarily be fixed upon the “disease-germs, which no bad air or foul drains can create,” any more than they could create vultures; but we must not therefore neglect the insanitary conditions, because the bad air will debilitate the system, and render it less able to withstand an attack of disease, while foul drains may be the direct means of conveying the disease-germ to a susceptible system; and this may be accomplished in one of two ways, — the first of which pertains especially to city life, while the second imperils both city and country folk. In our large cities we have sewers, with which are connected our wash-basins, bath-tubs, water-closets, and kitchen-sinks. They thus receive an enormous amount of animal and vegetable matter, which, unless very speedily removed, will be liable to decomposition, with its resultant gases. They also receive the water which has been used to wash the persons and clothing of patients suffering from measles, scarlet fever, and the like, the sputa of diphtheritic cases, and the dejections of those suffering from typhoid fever. If, therefore, the sewer becomes, in any way, choked, so as to allow of the formation and accumulation of the gases resulting from decomposition, these gases naturally seek to rise, and find their easiest outlet through insufficient traps, into our kitchen-sinks, water-closets, bath-tubs, and wash-basins; and it is probably in this way that disease-germs do, in some cases, find their way to susceptible systems. We believe, however, that this danger has been greatly overestimated, and that many cases which are apparently well traced to such a source should be credited to a very different one.

In a painstaking and able report on two epidemics of typhoid fever, in Crosshill and Eaglesham, suburbs of Glasgow, Scotland, in 1875, Eben. Duncan, M. D., repeatedly points out the fact that the occurrence of the disease did *not* coincide with insanitary conditions. For instance: “Here were all the conditions which would most certainly have originated a terrible outbreak of fever, had sewer gases been at this time capable of producing it. Sewer gases admitted freely on the surface of the drinking-water, sewer gases in the houses, choked and filthy privies on the common stairs, — what was the result? In tenement A, occupied by eight families, only one of these families was affected; in tenements B, C, D, and E, lived thirty families, among whom not a single case of the fever had occurred; in tenement F, one

¹ Professor John Tyndall, in *British Medical Journal*, June 24, 1871, page 661.

case occurred; in tenement G, two families were affected; in tenement H, no case occurred. Further, the cases which did occur occurred, as will afterwards be shown, not from sewer-gas poisoning, but from a different cause."

See, also, the very striking and important report on Diphtheria, — which is of course apropos here, as diphtheria belongs to this group of diseases, — in the Fifth Annual Report of the Board of Health of the City of Boston, dated April 30, 1877. We here find recorded a series of observations covering two years, during which there was "an unusual and destructive prevalence of diphtheria," resulting in "1064 deaths," which was "at the rate of 30.16 in every 10,000 of the population of the city, at all ages." Under the heading *Local Distribution* we find the following pertinent remarks: —

"Diphtheria is fatal in a tolerably uniform ratio of the number of cases attacked; that is to say, epidemics do not vary very widely in their intensity and destructiveness, so that statistics of death from this cause are a fair index of the inroads of the disease upon the public health. It is further obvious that facts pertaining to the local distribution of diphtheria are of especial interest in explaining and illustrating ætiological theories. If, for example, contagiousness is the essential characteristic of this disease, we shall find the deaths distributed quite generally, without regard to special local conditions. If, on the other hand, the disease depends for its origin and spread upon insanitary social and soil relations, we shall see epidemics shunning healthful localities, and always at home in ill-drained, sewage-sodden, miasmatic regions, inhabited by an unwholesome, overcrowded, improvident population. Now, what testimony has Boston to offer on these points, gathered from the experience of the last two years?"

Here comes a table, showing the mortality rates per 10,000 for each of the nineteen districts into which the city is divided, which can be intelligible only to those intimately acquainted with the topography of Boston. Then follows immediately: "These district mortality-rates do not present such distinctive characters as the believer in uncleanness as a cause of diphtheria would like to see. For example, the greatest number of deaths, in proportion to population, occurred in the upper part of East Boston, a section not specially characterized by unwholesome local or social conditions; much of the territory is high land, well drained, and occupied by a thrifty class of people. Then, again, District XIX. (Brighton), rural in character, sparsely settled, and presenting many attractive and apparently salubrious features, had a diphtheria death-rate considerably in excess of that of the city at large. On the other hand, we find that at the 'North End' (District IV.), a section whose name has, for many years, been synonymous with bad material and moral conditions, the inhabitants were

blessed with comparative immunity from the inroads of diphtheria, although the death-rate from croup was excessive. But the next adjacent section of territory (District V.) is a surprising exception; this is the region around Haymarket Square, a locality formerly occupied by a mill-pond, but at present inhabited, upon the poorly sewered filled land which has taken the place of the mill-pond, by a people of the poorer class, crowded in tenement blocks. In this insalubrious territory, presenting, in its filth and in its compact population, just the conditions for the spread of a miasmatic-infectious epidemic, the death-rate from diphtheria was lower than in any other portion of the city, — an anomaly most difficult to explain.”

“These results, it must be confessed, are a surprise, and, in some respects, a disappointment. The aetiology of diphtheria would be much clearer if we found the disease always most abundantly disseminated in localities well adapted for the germination and spread of the miasmatic and infectious group of diseases. We are compelled to admit that it has not been so found in this invasion.”

Anticipating, however, that the objection might be made “that considerable territorial areas may present quite uniform and satisfactory sanitary characters as a whole, while individual dwellings in those sections may have exactly the unwholesome qualities upon which stress is laid,” the writer goes on to show that “a careful examination was made of every dwelling in which a death from diphtheria or croup had occurred,” by an inspector who “was especially chosen for his fitness for the work, for his close observation, and keen and accurate detection of imperfections in dwelling-house hygiene.” The results of this inspection are thus summarized: —

“It thus appears, under the head of diphtheria, that nearly one half the premises inspected (forty-seven per cent.) presented nothing objectionable in point of drainage and general cleanliness; in thirty-nine per cent. the drainage was defective; in the small proportion of three per cent. the yards and cellars were dirty; and in the remaining eleven per cent. sunken lots, stagnant water, or filthy dumps made the surroundings open to objection. The summary for croup makes a still more favorable exhibition. It is, then, our duty, in view of the concurrent testimony, to reject the idea that filth fosters the origin and dissemination of diphtheria.”

These observations, emanating from so careful and reliable a source, and extending over a period of two years, are very significant, especially when we note the almost pathetic tone of disappointment in which the writer states the results to which he has been forced. During this time, diphtheria prevailed to an unusual degree within the city limits; and yet “less in the ‘South Cove District’ than in Brighton, less in the ‘Old Mill-Pond District’ than on Beacon Hill, and less at

the 'North End' than at West Roxbury." If it were not for the careful house-to-house inspection by an expert whom the Board so heartily indorses, some comfort might be derived by a belief in the faulty plumbing and trapping of the better class of houses. But even that satisfaction is denied to the believer in the filth origin of these diseases. In fact, that theory is utterly incompetent to explain the condition of things presented in this report.

Sewer gas, then, is not so black a devil as it has been painted. It is foul, noxious, a thing to be avoided and fought against; but it is not guilty of *all* the crimes that have been charged against it. But where *is* the culprit? Let us glance at our country cousins.

Typhoid fever has long been recognized as especially a disease of the country; and this will not seem surprising, when we remember the utter carelessness with which privies, drains, and manure-heaps are located with reference to wells and water-courses. Even these filthy leachings cannot, of course, originate the disease, unless they contain the specific contagia. But if the dejections from a typhoid-fever patient are deposited in a privy, or on a manure-heap, which is so placed that leaching may occur into the well, or brook, or river, it is impossible to say how far those contagia may travel before they find their way to an appropriate nidus, and light up what may appear to be an original case.

Moreover, we know that a large proportion of the farmers, situated within a radius of fifty or even a hundred miles of our large cities, look upon the sale of milk as a more or less considerable portion of their business; and that the city milk supply is daily gathered from hundreds of farms along the lines of railroad there centring. If, then, the water supply of even one of these farms should become contaminated by the dejections of a single case of typhoid fever, the contagia would be conveyed to just so many people as drank the milk coming from that farm. Nor, in saying this, do we necessarily accuse the farmer of watering his milk; for the mere washing of the pans and cans with such water would be quite sufficient. And we must remember that the contagia would naturally be attracted by a fluid so rich in nitrogen and water.

When we thus comprehend how hundreds of city people may be exposed to either one of the diseases of this group by the occurrence of a single case fifty miles away in the country; when we remember the yearly prevalence of these diseases through the country districts, and the usually complete ignorance of the city consumer in regard to the original source of his milk supply, we must stand appalled at the dangers to which we are continually exposed in the consumption of this most important and seemingly innocent article of food. And we *may* come to believe that milk may be even more dangerous than sewer gas.

That this is not the fearful imagining of mere theory, but plain and terrible truth, we will now prove by observed and recorded facts.

This subject has not, so far as we can learn, received the attention it deserves in this country. But in England several epidemics have been directly traced to the milk supply. From the appendix to Dr. Duncan's very valuable report I take the following particulars:—

“In September, 1857, a domestic servant, suffering from typhoid fever, was brought home from Liverpool to her parents in Penrith, who kept two or three cows, and retailed the milk to fourteen families in the town. Seven of these families took the disease. No case of the fever had happened in Penrith for some months before this girl's arrival.”

In 1870, an epidemic of typhoid prevailed in a small district of Islington. “One hundred and forty-two families were supplied by a particular dairyman, and seventy of these families were invaded by typhoid within ten weeks. . . . Suspicion rested on a fouled water-tank, the water of which was used for washing the milk-cans. The family of the dairy-man, *who died of the disease*, denied that water had ever been used for diluting the milk. . . . We have yet left the admitted fact that the cans were washed at the pump.”

In 1872, an epidemic occurred in Armley, in the borough of Leeds. It was reported on by Dr. Ballard, who traced it to the milk supply of a particular dairy, in which the dairyman himself was lying ill with typhoid fever, and where two of his children also suffered from the same disease. One hundred and seven cases occurred in this epidemic, which suddenly ceased on July 27th. The following is an extract from Dr. Ballard's report:¹ “This sudden cessation of the fever epidemic among this section of the community on July 27th means that the cause of the epidemic had ceased, for them, a fortnight or more previously; since in enteric fever there are commonly eleven days of incubation, and several other days before medical advice for its symptoms is sought, July 10th would therefore be about the time when the cause of the epidemic among customers of the dairy suddenly ceased to operate. Now, on July 10th Dr. Robinson had the handle of the pump at the Hall Lane Dairy chained up, and thenceforth it was kept chained. There was coincidence, therefore, between the cessation of the fever and the cessation of the opportunity that the dairy had to supply a particular water, while there was no suggestion that the cows or their milk had undergone any change. . . . The dairyman's house is one of three cottages. The well is sunk (close to end wall) to a depth of thirty-six feet, in the porous shale of the district. On removing stone cover, the depth of water was found to be twelve feet. A large dung-pit, full of manure, was situated about five yards off, and a privy and sunken tub

¹ Official Report upon an Outbreak of Enteric Fever at Armley, Leeds, 1873.

for urine a few yards off in another direction." The well was found to be foul.

Another epidemic occurred in Leeds in 1872, which was reported by Dr. Robinson.¹ He says: "A farm-house in the country became infected with typhoid fever towards the latter end of September; the head of the house died, and subsequently five members of the household suffered from the disease. Milk from this infected source, purchased by a Leeds dairyman, was supplied to a certain respectable district of the town, in which locality a virulent outbreak of typhoid manifested itself, and eighty persons who obtained their milk from this dairyman contracted fever, fourteen of whom died."

In 1873, an epidemic occurred at Parkhead, Glasgow, and was reported by Dr. Russell.² He says: "Of seventy-three families supplied by a particular dairyman, who had three children suffering from typhoid, twenty-two had fever."

At Bolton, forty-seven out of fifty families, supplied by the same dairyman, were smitten with typhoid fever. The brook which supplied that dairy with water was found to have been contaminated, higher up, by the dejections of a typhoid patient.³

In 1875 occurred the epidemics in Crosshill and Eaglesham, reported by Dr. Duncan, in which he very clearly and distinctly traces the infection to the milk supply. We have quoted from him (page 10) to show that cases did not arise from sewer gas; and he there promises to show us that such cases as did occur, in those crowded and sewer-gas-filled tenements, arose from another cause. See what further he has to say about them: "Of the total number of fifty-nine families living in these eight tenements, four families had fever, and these four families got their milk supply from the three Eaglesham dairies [which he has shown to have been contaminated], and in every case almost entirely from that source."

When we arrive at a full comprehension of this source of typhoid fever, our first feeling is one of dismay at the difficulties to be encountered in tracing the epidemics of large cities, and still more in securing efficient preventive measures; but our second feeling is one of relief, in the fact that we have at last discovered a principal source of this insidious group of diseases, and thus know where we must direct our energies. Prevention, to be effective, must be radical. There is at present no known way of destroying contagia in such a fluid as milk, except by the prolonged exposure of such fluid to a very high temperature. Ordinary boiling is quite insufficient for the purpose. Real prevention could be secured only by legislative enactment for-

¹ Report on Sanitary Condition of Leeds, 1872.

² Glasgow Medical Journal, August, 1873.

³ Dr. John Dougall, Glasgow Medical Journal, May, 1873.

bidding the sale of milk, in either large or small quantities, without a license, which license should be obtainable only after thorough inspection of the premises by an officer appointed for this duty by the State Board of Health; and these licenses should be good for one year only, and should be renewed only after renewed inspection. With a sufficient number of competent and faithful officers assigned to this duty, there is no reason why our milk supply should be contaminated by these germs, and so one most important source of contagion would be removed.

We fully appreciate the enormous difficulties in the way of securing such legislation, on account of the ignorance and apathy of the legislators and of the powerful opposition which would be brought to bear by the dairy interest. But if the people could be made to see (1) the enormous death-rate from the contagious fevers, (2) the great danger of drinking milk containing contagia, and (3) the strong probability of such contamination of their milk supply, owing to the ignorance and carelessness of dairymen, public opinion would soon demand the passage and strict enforcement of such preventive measures.

But in the mean time we must individually do what we can — by the disinfection of stools at the moment of passage, the early disinfection of soiled clothing, and the most careful inspection of the water and milk supply — to reduce the chances of contagion. And here is opened up a grand field for labor for our country brethren. Let them each and all carefully inspect the dairy farms in their respective neighborhoods; advise with the farmers in regard to the sanitary conditions of their premises; and, on the occurrence of disease, promptly notify their own patients, and also their brethren in the city or town to which the milk from that farm is supplied. By such a course they could effectually prevent a large proportion of the epidemics which now scourge our cities year after year, avert an incalculable amount of anxiety and sorrow, and rob grim death of many a victim.

